

REMARKS

Claims 1-4 and 6 stand rejected under 35 U.S.C. § 112, second paragraph. This rejection is respectfully traversed for the following reasons.

The Examiner has requested Applicants to expressly identify the meaning of the term “capacity percent.” As previously mentioned, “capacity percent” is a well-know term in the art defining gas concentration, as evidenced by the cited patent in Applicants’ previous response. Nonetheless, the meaning is restated here for the Examiner’s reference. In particular:

$$\text{Capacity Percent} = \frac{\text{Capacity of specific gas (L/min)}}{\text{Total Capacity of gas in chamber (L/min)}} * 100$$

The following example is being submitted to further clarify the meaning of capacity percent, and is based on page 16 of Applicants’ specification. In particular, hydrogen flows at 3L/min, nitrogen at 13 L/min and ammonia at 4 L/min so that the corresponding capacity percents are 15%, 65% and 20%, respectively. That is, the denominator of the above equation is 3+13+4=20, while the specific capacities (i.e., flow rates) are 3 for hydrogen, 13 for nitrogen and 4 for ammonia. Accordingly, using the above equation, the capacity percent for each gas is determined as follows: hydrogen is 3/20=15%; nitrogen is 13/20=65%; and ammonia is 4/20=20%.

Based on all the foregoing, it is submitted that claims 1-4 and 6 are definite. Accordingly, it is respectfully requested that the rejection under 35 U.S.C. § 112, second paragraph be withdrawn.

Claims 1-4, 6-10 and 13-16 stand rejected under 35 U.S.C. § 103 as being unpatentable over Sugiura et al. in view of Keller. This rejection is respectfully traversed for the following reasons. Claims 1-16 have been canceled in favor of new claims 17-34 which define similar subject matter. It is respectfully submitted that new claims 17-34 do not raise new issues that

would require further consideration and/search. For example, claim 17 is similar to previous claim 1 + 3, etc.. As it is believed that this amendment places the application in immediate condition for allowance, it is respectfully requested that the amendment be entered and the application passed to issue.

Claims 17, 27, 29, 33 and 34 are independent, and each defines a novel cooling process which includes the combination of hydrogen and cooling parameters that are not disclosed or suggested by the prior art. In fact, Keller expressly teaches away from the claimed invention by suggesting a *hydrogen-free* cooling process so as to produce a low-resistivity layer (*see* col. 4, lines 29-36). That is, even assuming *arguendo* that Keller implicitly suggests that a hydrogen atmosphere during the cooling process may be possible (but not desirable as taught by Keller), Keller does not suggest experimenting with cooling parameters (e.g., cooling rate/time) for use with a hydrogen atmosphere. Instead, Keller merely suggests eliminating hydrogen altogether during the cooling process. It is respectfully submitted that Keller expressly leads away from suggesting experimentation in a cooling process having a hydrogen atmosphere. Sugiura et al., on the other hand, is further removed from the present invention in that it merely discloses using ammonia/nitrogen during a *natural* cooling process (silent as to hydrogen gas *per se*) and acknowledges that such a process will result in an increased resistivity of the layer. Indeed, as set forth in Comparative Examples 1 and 2 described at col. 13, lines 42-63 and col. 14, lines 10-11, a high resistance layer is obtained during the aforementioned disclosed cooling process.

In this regard, it is noted that examiner-optimization requires the prior art to first recognize that the features being optimized (i.e., hydrogen content and cooling parameters) are result-effective variables. The Examiner is directed to MPEP § 2144.05(II)(B) under the heading

"Only Result-Effective Variables Can Be Optimized", which sets forth the applicable standard for determining result-effective variables:

A particular parameter must first ***be recognized*** as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. (citing *In re Antonie*, 195 USPQ 6 (CCPA 1977)).

In the instant case, the cited prior art is completely silent as to the importance of the cooling parameters (rate/timing) and thereby does not recognize the cooling parameters as result-effective variables, let alone the ***combination*** of hydrogen content and cooling parameters achieving a recognized result. Instead, the cited prior art at best suggests that hydrogen content ***individually*** is not desirable during the cooling process without taking into consideration the effects of the cooling parameters in combination therewith.

Only Applicants have discovered a means by which hydrogen can be used during the cooling process while still maintaining a low-resistivity layer, so as to simplify the manufacturing process by eliminating the need to purge hydrogen (as required in Keller) while improving the resulting semiconductor layer by reducing degradation caused by rapid change in gas content during a purge of hydrogen. In particular, Applicants have conceived of the needed relationship between the cooling process parameters and hydrogen content to overcome the deficiencies of the prior art so as to produce low resistance semiconductors using cooling processes that include hydrogen. In this way, use of hydrogen during both the growing and cooling process can be realized so as to avoid degradation that may be caused by a rapid change of gas (e.g., purging hydrogen after growth process) while still maintaining a low resistivity semiconductor layer.

Indeed, as shown in Figure 5 of Applicants' drawings, only Applicants have identified the unexpected variation in the hole carrier concentration when the substrate temperature is

cooled from approximately 950°C to 600°C. In view of this discovery, Applicants conceived of a novel **combination** of hydrogen content and cooling time/rate which would enable forming a low resistivity layer (e.g., hole carrier concentration of approximately $1 \times 10^{16} \text{cm}^{-3}$ or higher at room temperature) even when using hydrogen during the cooling process (*see, e.g.*, Figures 6-8 of Applicants' specification). In this regard, Applicants' conceived combination of hydrogen content and cooling parameters sets forth new and unexpected results as mentioned above and described throughout Applicants' specification, whereas the cited prior art merely expects degradation of the semiconductor layer when hydrogen is used during the cooling process and therefore eliminates hydrogen altogether during the cooling process. Nonetheless, the cited prior art certainly does not suggest the claimed combination of hydrogen content and cooling parameters nor provide any motivation for pursuing such a combination.

The Examiner is directed to MPEP § 2143.03 under the section entitled "All Claim Limitations Must Be Taught or Suggested", which sets forth the applicable standard:

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. (citing *In re Royka*, 180 USPQ 580 (CCPA 1974)).

In the instant case, the pending rejection does not "establish *prima facie* obviousness of [the] claimed invention" as recited in claims 17, 27, 29, 33 and 34 because the proposed combination fails the "all the claim limitations" standard required under § 103.

Under Federal Circuit guidelines, a dependent claim is nonobvious if the independent claim upon which it depends is allowable because all the limitations of the independent claim are contained in the dependent claims, *Hartness International Inc. v. Simplimatic Engineering Co.*, 819F.2d at 1100, 1108 (Fed. Cir. 1987). Accordingly, as the independent claims are patentable for the reasons set forth above, it is respectfully submitted that all claims dependent thereon are also

patentable. In addition, it is respectfully submitted that the dependent claims are patentable based on their own merits by adding novel and non-obvious features to the combination.

Based on all the foregoing, it is submitted that all pending claims are patentable over the cited prior art. Accordingly, it is respectfully requested that the rejection under 35 U.S.C. § 103 be withdrawn.

CONCLUSION

Having fully and completely responded to the Office Action, Applicants submit that all of the claims are now in condition for allowance, an indication of which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, the Examiner is requested to call Applicants' attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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